

# **Safety Practices In Steel Authority Of India Limited**

**and**

## **An analysis on Kolkata Flyover Collapse**

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Department of Chemical Engineering  
**National Institute of Technology Rourkela**

# **Safety Practices In Steel Authority of India Limited and An Analysis on Kolkata Flyover Collapse**

*Thesis submitted in partial fulfilment*

*of requirements of the degree of*

***Master of Technology***

*in*

***Safety Engineering***

*by*

***Abhipsa Das***

(Roll No: 214CH2522)

*under the supervision of*

***Dr. R.K.Bag***



May 2016

Department of Chemical Engineering  
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May 2016

## **Certificate of Examination**

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We the below signed, after checking the thesis mentioned above and the official record book (s) of the student, hereby state our approval of the dissertation submitted in partial fulfilment of the requirements of the degree of Master of Technology in Safety Engineering Department of Chemical Engineering at National Institute of Technology Rourkela. We are satisfied with the volume, quality, correctness, and originality of the work.



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## **Supervisors' Certificate**

This is to certify that the work presented in the dissertation entitled **Safety Practices in Steel Authority of India Limited and An Analysis on Kolkata flyover collapse**, submitted by **Abhipsa Das**, Roll Number 214CH2522, is a record of original work carried out by her under my supervision and guidance in partial fulfilment of the requirements of the degree of Master of technology in Safety Engineering. Neither this report nor any part of it has been submitted earlier for any degree or diploma to any institute or university in India or abroad.

**Dr. R.K.Bag**  
Professor

# Declaration of Originality

I, **Abhipsa Das**, Roll Number **214CH2522** hereby declare that this thesis entitled **Safety Practices in Steel Authority of India Limited and An Analysis on Kolkata Flyover Collapse** presents my original work carried out as a post graduate student of NIT Rourkela and, to the best of my knowledge, contains no material previously published or written by another person, nor any material presented by me for the award of any degree or diploma of NIT Rourkela or any other institution. Any contribution made to this research by others, with whom I have worked at NIT Rourkela or elsewhere, is explicitly acknowledged in the Thesis. Works of other authors cited in this thesis have been acknowledged under the section “Bibliography.” I have also submitted my original research records to the scrutiny committee for evaluation of my thesis.

I am fully aware that in case of any non-compliance detected in future, the Senate of NIT Rourkela may withdraw the degree awarded to me on the basis of the present dissertation.

May 2016

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# Acknowledgment

The satisfaction on successful completion of any task would be incomplete without the mention of the people who made it possible whose constant guidance and encouragement crowned out effort with success. I would like to express my heartfelt gratitude to my esteemed supervisor, **Prof R.K.BAG** for his technical guidance, valuable suggestions, and encouragement throughout the study and in preparing this report. It has been an honour to work under **Prof R.K.BAG**, whose expertise and discernment were key in the completion of this project. I am grateful to the **Dept. of Chemical Engineering, NIT ROURKELA**, for giving me the opportunity to execute this project, which is an integral part of the curriculum in M.Tech program at the National Institute of Technology, Rourkela.

Many thanks to my friends who directly or indirectly helped me in my project work for their generous contribution towards enriching the quality of the work.

This acknowledgement would not be complete without expressing my sincere gratitude to my parents for their love, patience, encouragement, and understanding which are the source of my motivation and inspiration throughout my work. Finally I would like to dedicate my work and this project to my project guide **Prof R.K. BAG**.

Abhipsa Das

# Abstract

Nowadays safety has become an important aspect which is taken in every industry all over the world. Safety has become an important factor in industry in order to provide a safe working environment for the employees, workers working inside the industry premises. In India the main concern for safety aroused from the Bhopal Gas tragedy which had an adverse effect on environment, people and resources. In India where safety is still at infancy, one needs to take care of the safety issues which are coming over in long run.

Here we are basically concern over the safety practices which are followed in SAIL. The different branches of SAIL and its safety practices is taken into account. An analysis of the recent Kolkata flyover collapse is prepared and different safety issues which are lacking behind and which lead to the failure with the possible reasons of failure and consequences and losses are prepared.

***Keywords: Safety issues, infancy, flyover collapse***

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# List of Abbreviations

SAIL .....	Steel Authority of India Limited
HIRA .....	Hazard Identification and Risk Analysis
RINL .....	Rashtriya Ispat Nigam Limited
SOPs .....	Standard Operating Procedures
NSC .....	National Safety Council
SSP .....	Salem Steel Plant
VISL .....	Visvesverya Steel Plant

## **Chapter 1**

# **Introduction**

The Indian steel industry has entered into a new development stage from 2007-08, riding high on the increasing after a period of little activity, economy and rising demand for steel. The rapid rise in production has resulted in India becoming the 3<sup>rd</sup> largest producer of crude steel in 2015 and the country continues to be the largest producer of sponge iron in the world. As per the report of the Working Group on Steel for the 12th Five Year Plan, there exist many factors which carry the potential of raising the per capita steel consumption in the country. These include, an estimated infrastructure investment of nearly a trillion dollars, a projected growth of manufacturing from current 8% to 11-12%, increase in urban population to 600 million by 2030 from the current level of 400 million.

The rural market of steel consumes around 10 kg per annum influenced by projects like Bharat Nirman, Pradhan Mantri Gram Sadak Yojana, Rajiv Gandhi Awaas Yojana among others. SAIL has different key elements towards safety: Effective health and safety policies which set a clear direction for the organization to follow safety measures. An effective management structure and arrangements are in place for delivering the policy. There is a planned and systematic approach to implementing the safety and health policy through an effective health and safety management system. The Performance is measured against agreed standards to reveal when and where improvement is needed. The organization learns from all relevant experience and applies the lessons. The National Steel Policy 2005 is currently being reviewed keeping in mind the rapid developments in the domestic steel industry (both on the supply and demand sides) as well as the stable growth of the Indian economy since the release of the Policy in 2005.

The different safety practices which are followed by different branches of SAIL and with the reportable and non reportable accidents and fatalities is found out.

## 1.1 Sail- Steel Authority Of India Limited

An overview of the how the works are done, policies are applied, planning is done, implementation, operation, checking and corrective action with management review is taken into account.

### OHSAS 18001

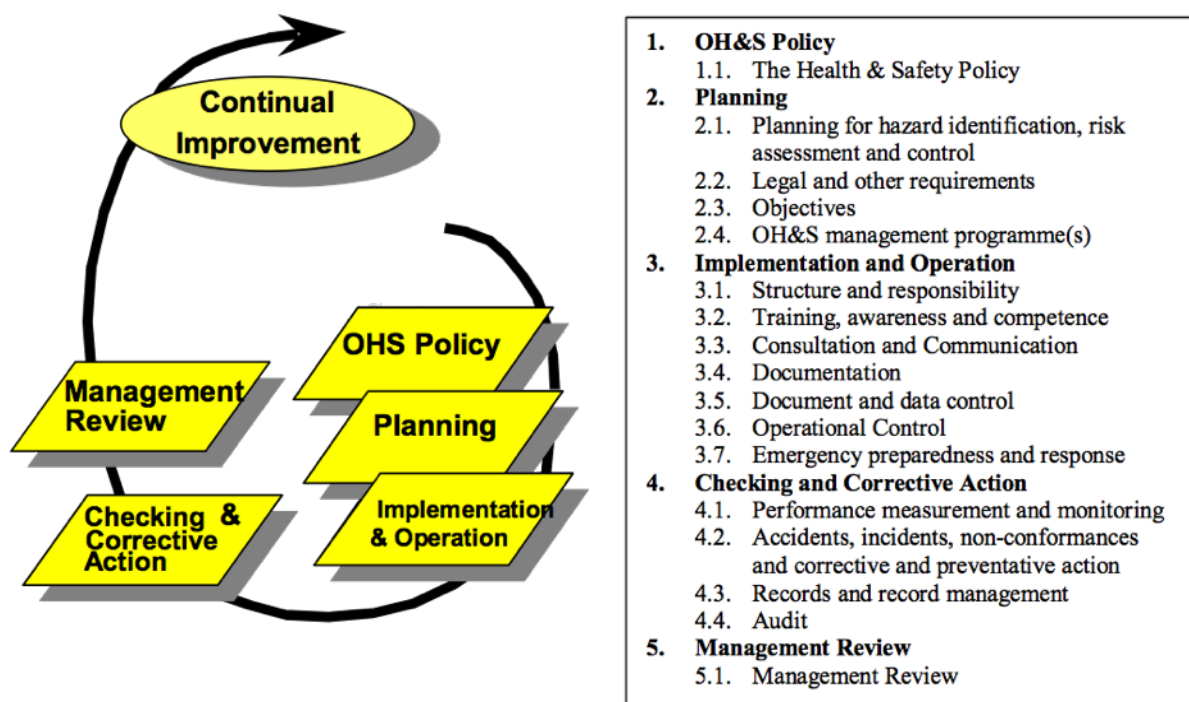


Figure 1.1 : View of SAIL planning system

Policy- For effective health and safety policies a clear direction needs to be set for the organization to follow.

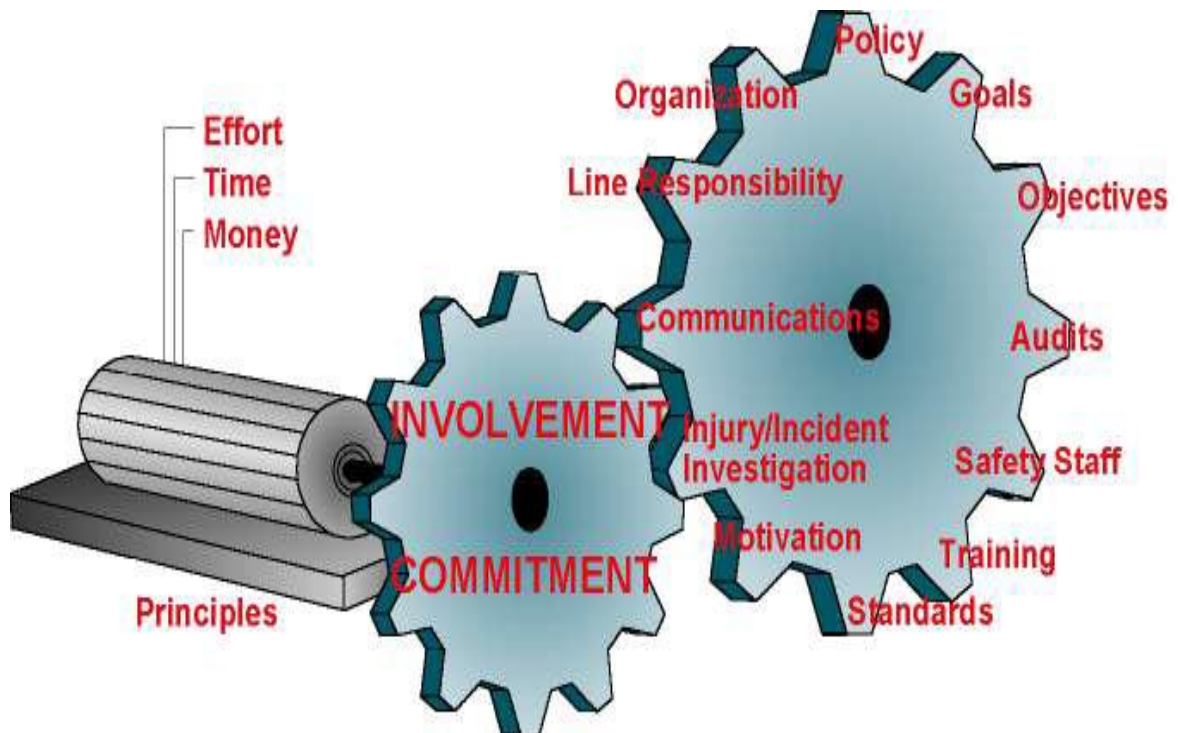
Organizing- An effective management structure and arrangements are to be in place for delivering the policy.

Planning- There is a planned and systematic approach to implement the health and safety policies through an effective health and safety management system.

Measuring Performance- Performance is to be measured against agreed standards to reveal when and where improvement is needed.

Auditing and Reviewing of Performance-The organisation learns from all relevant experience and applies the lessons.

## 1.2 Safety Management System



**Figure 1.2 View of Safety Management System**

The most important 3 characteristics of safety management system is effort, time and money. In order to achieve a zero accident rate an organization needs to provide these 3 basics. The very next principle of the safety management system is the involvement and commitment towards the assigned work. Since without involvement a work cannot be completed and without commitment the goals and objectives set cannot sustain. After this then comes the actual responsibility of the organization. It is because an organization needs to set goals, objectives and motivate employees to work for safety. For this management needs to appoint safety officers, provide trainings to the worker class people and try to change their mindset and made them work with all safety measures. Also communication is the most important aspect for safety management system. And for effective communication the employees at high position needs to interact with the worker class on a regular interval so that the worker class can put up their views for improving safety standards.

### **1.2.1 Safety Policy**

Steel Authority of India Limited(SAIL) is committed to the following safety policies:

- a) Safety of its employees and the people associated with it including those living in the neighborhood of its plants, mines and units.
- b) SAIL pursue safety efforts in a sustained and consistent way by establishing safety goals, demanding accountability for safety performance and providing resources to make safety program work.

### **1.2.2 Guiding Principles**

These are the following guiding principles which is followed by SAIL:

- a) There is a excellence in health and safety supports which leads to excellent business results.
- b) All accidents can and must be prevented.
- c) All employees are responsible and accountable for maintaining safety standards.
- d) Safety standards to be incorporated in all work procedures.
- e) Impart training to create safety consciousness and to work safely to be a key element of safety programs.
- f) There is a comprehensive and regular audit of the safety performance to be conducted.
- g) All work practices and procedures to be in consonance with statutory rules and regulations on safety.

### **1.2.3 Organization Of Safety Management In Sail**

Each plant of SAIL has a fully fledged Safety Engineering department headed by GM(Safety & Fire Services) to take care of operational safety & fire related aspects on

day-to-day basis. Each department / shops have Departmental Safety Officer to promote safety awareness amongst the employees. GM(Safety & Fire Services) reports to concerned ED(Works) who is Occupier as per the statutory requirement. SAIL Safety Organization (SSO) was set up at Ranchi in 1988 to coordinate, monitor & facilitate the safety related activities of Plants/ Units. 386 personnel exclusively look after safety activities in SAIL.

#### **1.2.4 Approach Towards Safety In Sail Plants**

Mitigation of hazards and risks: These are the following mitigation of hazards and risks which are an approach towards safety in SAIL:

- a) Technological Intervention: It includes
  - i. Interlocks, alarms/annunciation, safety valves and seals
  - ii. Enhanced automation/mechanization, use of CCTV etc.
  - iii. Use of Residual Current Circuit Breakers, Earth Leakage Circuit Breakers, Fire retarding cables and paints, fire barriers etc.
- b) SOPs and SMPs, Protocols and statutory provisions
- c) Hazard Identification & development of HIRA
- d) Mock Drills for emergency preparedness
- e) Provision & usage of conventional & Job specific PPEs
- f) Regular review and monitoring
- g) Audits and Preventive inspections
- h) Drives & Campaigns
- i) Training & educational programs for awareness, motivation for safe behavior.



### **1.2.5 Safety Audits**

There are two types of safety audits:

#### **1. Internal Audits**

- a. Safety Engineering Department in association with Departmental Safety Officer of the concerned shop.
- b. SSO mainly in Hazardous/ Major Accident Hazardous units of Plants & Units through an audit team comprising executives from Plants & SSO.

These audits are carried out as per the procedure prescribed under **IS -14489:1998** ‘Code on Occupational Health and Safety Audit’.

#### **2. External Audits**

- a. Conducted by Independent third party like National Safety Council (NSC), Regional Labor Institute (RLI) under DGFASLI, competent person recognized by concerned state factory inspectorate etc. as per requirement. SAIL has MOU with NSC in the areas of Safety Audit.
- b. Surveillance audits are conducted on six monthly basis in OHSAS-18001:2008 certified Plants / units like BSP, BSL, DSP, RSP & SSP by external agencies like M/s DNV, TUV etc.

Internal audits are conducted prior to above by a team of certified lead auditors.

Recertification audits are conducted before renewal of certification.

### **1.2.6 Accident Reporting/ Investigation Analysis**

#### **1.2.6.1 Reporting:**

The Employees sustained injuries in course of working report to OHSC of the plant for First Aid and further treatment (as needed). IOW (Injury On Work) form is filled up by

the concerned in-charge of the department. In case of Reportable Accident (employee remains absent from duty for more than 48 hours), Inspector of Factories (Statutory Authority) is informed. In case of Fatal Accident, information is reported to Ministry, statutory authority & Corporate Office.

#### **1.2.6.2 Investigation:**

Every accident is investigated by Safety Officer of the department. In case of Fatal and major accidents, enquiry committee constituted at plant level for investigation. 'On the Spot Study' is also conducted by SSO, Ranchi for fatal accidents.

#### **1.2.6.3 Analysis:**

Every accident is analyzed after investigation and root cause is determined. The recommendations to avoid recurrence of such accident are suggested. The accidents are analyzed by Cause, Shop/ Location, Age, Shift, Category .

### **1.2.7 Safety Training, Communication And Motivation:**

#### **1.2.7.1 Training:**

These are the following training which are provided:

- a. Induction training imparted to all contractual workers before issue of Gate Pass.
- b. 'On the Job Training' is imparted at respective work place.
- c. The Height Pass training before issuance of Height Pass for allowing to Work at Height.
- d. Specialized safety training on identified areas for target group of employees.
- e. Trade specific training.
- f. Awareness Workshops for Regular & Contractor employees.

### **1.2.7.2 Communication:**

For better communication these are the points which are to be considered:

- a. Safety Circulars/ Office Orders, Display of Do's & Don'ts .
- b. Display of MSDS, Caution Boards / Notices etc. in English & Local language.
- c. Safety Message at Entry points, Telephone, Mobile PA system, Display on Mobile vans, Local TV network, Safety drama/ skit, Safety exhibition.

### **1.2.7.3 Motivation:**

These Are The Motivational Steps Which Needs To Be Followed:

- a. Zero Accident Recognition Scheme For Departments,
- b. Housekeeping Competition Amongst Departments
- c. Various Competitions Are Organized Department Wise And Also During National Safety Day Celebration.

## **1.2.8 Inspections, Drives And Campaigns**

The inspection is done by Shop Departmental Safety Officer (DSO), SED in association with DSO, Apex Safety committee, Fire Services Department, joint inspections.

### **1.2.8.1 Drives And Campaigns:**

These are the following drives and campaigns which are to be followed:

- a. Usage of crash helmets
- b. PPEs
- c. Checking of heavy vehicles
- d. Roko-Toko

- e. Machine Guarding
- f. Provision of hand railings & toe guards in platforms
- g. Earthing in electrical equipment
- h. Housekeeping
- i. EOT Cranes etc.

### **1.2.9 Safety Efforts By SSO(Safety Security Officer)**

The function and responsibilities of safety officers are as follows:

- a) Monitoring of Safety & Fire Service activities –  
Collection, Compilation & dissemination of:
  - ❖ Daily Safety Statistical Report
  - ❖ Monthly Report
  - ❖ Annual Report.
- b) Discussion & Interaction with Senior Management, Line Functions & Safety personnel.
- c) The review through periodic meetings of Heads of Safety (HoS) and Heads of Fire (HoF) Services of Plants/ Units.
- d) The audit of Major Accident Hazard (MAH) units and other deptts. including Modernization & Expansion areas, Mines and Warehouses.
- e) ‘On the Spot Study’ of Fatal & Serious accidents and dissemination of recommendations to prevent recurrence.
- f) Organizing Training/ Workshops / Seminars at Ranchi & P/Us.
- g) Analysis of accident statistics, review for corrective actions.

- h) Facilitating new initiatives for continuous improvement.
- i) Secretarial function of 'Joint Committee on Safety, Health and Environment in Steel Industry' (JCSSI).
- j) Publication of educative materials and In-house journals.

**Table 1.1: Safety Audits Plan For 2015-2016 In Sail**

Plant/Unit	Areas/Dept
BSP	OP-II, COB#1-11, BF#1-7, PROJECTS AREA
DSP	SECTION MILL, POWER PLANT, BOF, CCP
RSP	SMS-II
BSL	HSM, TRAFFIC, HRCF, WMD, RMHP, CRM-III, ENGG SHOPS
ISP	USM, OHP
ASP	MILLS AREA
BSP(M)	DALLI MECH. MINE
CMO	KANPUR WH

**Table 1.2: Safety Audits Conducted By External Agencies In Sail**

Plant/Unit	Agency	Date
BSP	NSC	22-27 <sup>th</sup> Sept.`14
DSP	NSC	18-22 <sup>nd</sup> Aug.,14
RSP	NSC	22-27 <sup>th</sup> Sept.`14
BSL	NSC	13-18 <sup>th</sup> Oct.14
ISP	NSC	10-15 <sup>th</sup> Sept.`14
CFP	NSC	22-25 <sup>th</sup> July'14
RHD(GUA MINES)	NSC	20-28 <sup>th</sup> Aug.`14
SSP	RLI, Chennai	6-10 <sup>th</sup> Oct.`14
VISL	RLI, Chennai	8-12 <sup>th</sup> Dec.`14

### **1.2.10 Heads Of Safety Meeting At RSP: 12-13Th May 2015**

The Salient issues which were discussed in the meetings are as follows:

- a) Implementation of Suraksha Chakra scheme in Plants/ units
- b) Safety promotional drives & campaigns
- c) Preparation & adherence to safe Commissioning Procedure for new facilities
- d) Updating of HIRA, SOPs & SMPs and educating people on its contents
- e) Conducting internal safety audits by SED

- f) Compliance status of safety audits conducted by SSO
- g) Augmentation of infrastructural facilities for contractor workers training including provision of height rigs
- h) Motivational scheme for reporting of near miss cases.

## **Chapter 2**

# **Safety Initiatives Taken By Different Plants**

### **2.1 BSP (Bhilai Steel Plant)**

It is located in Bhilai in the state of Chhattisgarh. This plant is India's first and the main producer of steel plates and other steel plates and steel products. The plant is the sole supplier of the country's longest rail tracks which measures 260metres. This plant is eleven time winner of Prime Minister Trophy for best integrated steel plant and contributes in the largest percentage of profit.

The following safety initiatives were taken by BSP:

- a) New reporting system introduced for DSOs.
- b) Transportation of materials by fowler / hydra is banned
- c) Special trainings for contractual workers of major departments/shops of works area are organized at HRDC conference hall.
- d) 51 DSO's were imparted hands-on training on use of gas masks by EMD
- e) HAZOP study (in-house) discussions were made with Coke Ovens, Blast Furnaces, R&SM, EMD, SMS-2 & WMD departments. Action plans have been prepared by all the concerned departments.

### **2.2 DSP (Durgapur Steel Plant)**

It is located in Durgapur, in eastern India, West Bengal and was set up with the help of UK in late 50's. It has an initial capacity of 1 million tonnes of crude steel but later expanded into 1.6 million tonnes. The modernization have brought an improved productivity, substantial improvement in energy conservation and better quality of products in the plant organization.



The following safety initiatives were taken by DSP

- a) The placement of work order on DMI-Bhopal for DMP preparation and HAZOP studies.
- b) Engaging external experts ( IISM , DSS&PE) for increasing safety awareness amongst regular as well as contract workers.
- c) Senior Management Task Force on Safety make surprise visits to check unsafe acts/at-risk behaviors.
- d) Effective involvement and utilization of bipartite forums on safety (PCCS & DCCS).

### **2.3 RSP (Rourkela Steel Plant)**

It is the first integrated steel plant in the public sector in India. It was set up with German collaboration with an installed capacity of 1 million tonnes. With rapid modernization and expansion the capacity of production enhanced. In the year 2015 during prime minister Narendra Modi visit to Rourkela Steel Plant , he provided a Rs 12,000 crore modernization and expansion project dedicated to the built of the nation.

The following safety initiatives were taken by RSP:

- a) Implementation of Surakshya Chakra.
- b) New format developed & circulated for reporting & token gift introduced to encourage reporting.
- c) Special road safety checking by GMs, HOD & SED started in strategic road locations as per monthly schedule Roster list.
- d) Retro reflective Safety sign boards were displayed at different location. Speed breakers were provided in strategic locations(22nos) to regulate the speed.
- e) Safe commissioning of new units.

- f) Visitor safety video clip developed & being conducted at Surakshya Cell at HRDC.

## **2.4 BSL (Bokaro Steel Plant)**

It is located in the Bokaro district of Jharkhand and is the fourth integrated steel plant in India built along with Union Soviet help. It got incorporated in 1964 and then later merged with SAIL. The modernization aims in increasing the liquid steel production capacity, coupled with fresh rolling and coating facilities.

The following safety initiatives were taken by BSL:

- a) On the job safety Awareness Training sessions are being organized exclusively for Contractual workers & their supervisors in major departments.
- b) ROKO-TOKO and Inspection by Full SED team in different departments.
- c) Photographs of Unsafe Conditions / Acts with 'before & after compliance' .

## **2.5 ISP (IISCO Steel Plant)**

It is located at Burnpur in Asansol. It is the 2nd largest integrated steel plant after TISCO. With the modernization and expansion the plant is presently undergoing the final touches of a Rs 16,480 crore to raise its saleable steel capacity to 2.5 million tonnes per year.

The following safety initiatives were taken by ISP:

- a) Use of height rig for enhancing skill & competency.
- b) Study on 'Readiness to Operate' was conducted by M/s Dupont for BOF & CCP.
- c) HAZOP study conducted through external agency and draft report submitted to MECON .

## Chapter 3

# Safety Performance

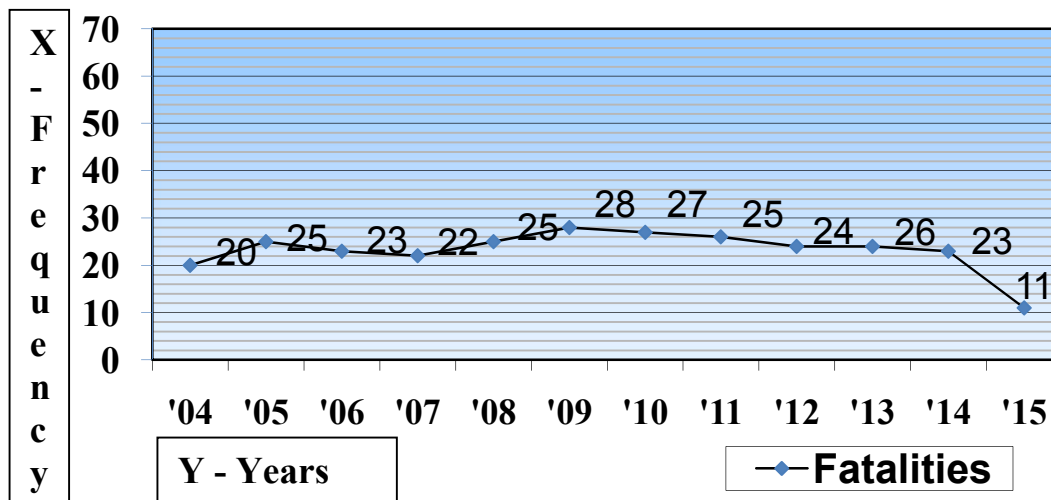


Figure 3.1 trend of fatal accidents is plotted with frequency of injuries in x-axis and time in y-axis from 2004-2015

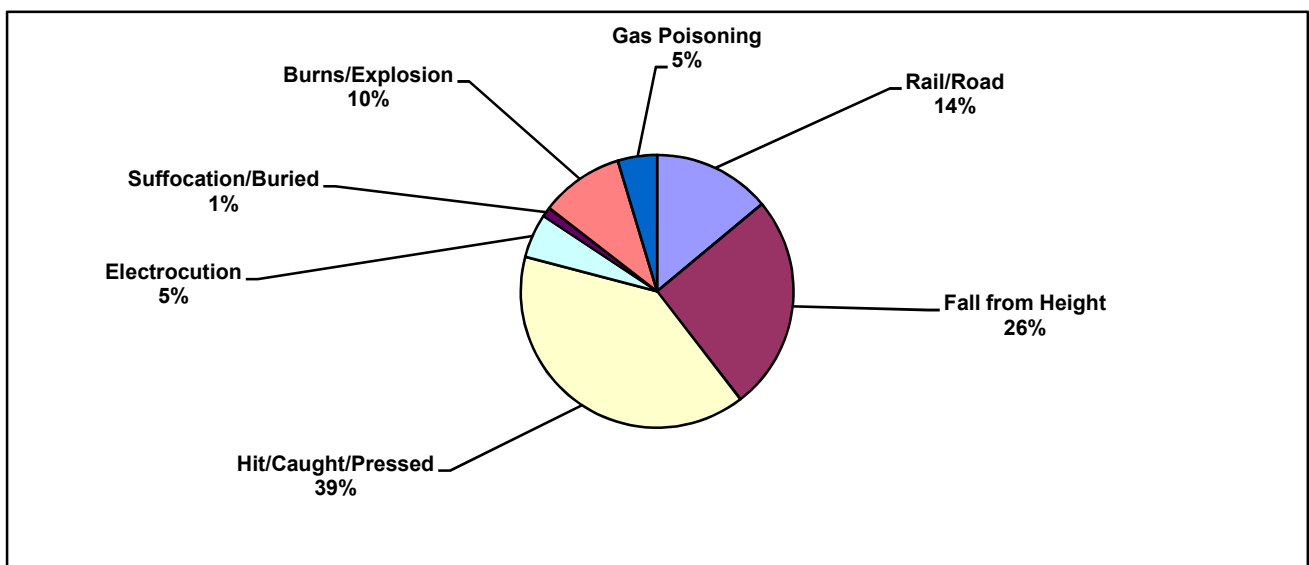


Figure 3.2 causes of accidents

### 3.1.0 Trend Of Accidents – 2001 To 2015

#### Reportable Accidents

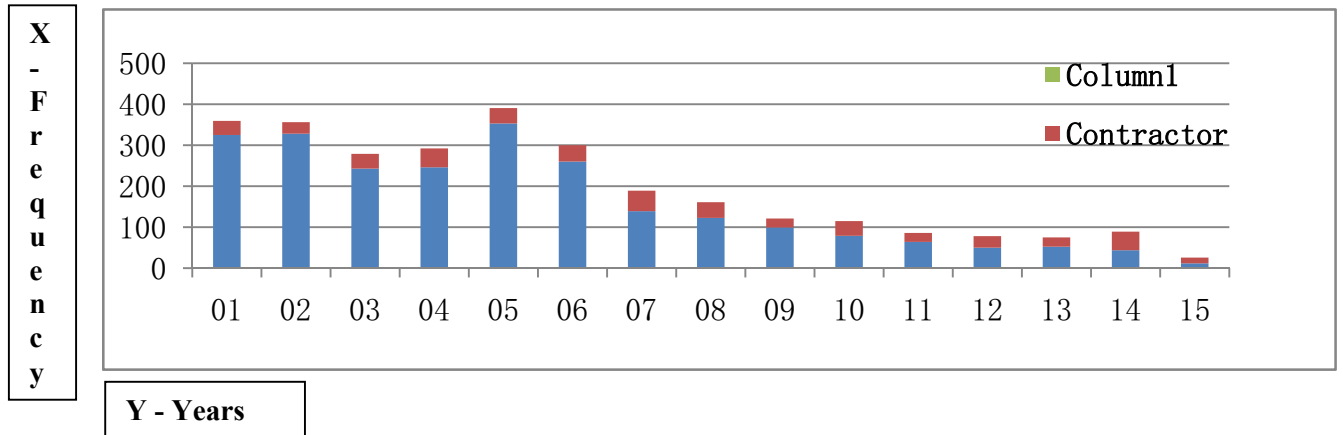


Figure 3.3 Reportable accident in SAIL plotted with frequency of injuries in x-axis and year in y-axis

#### Non Reportable Accidents

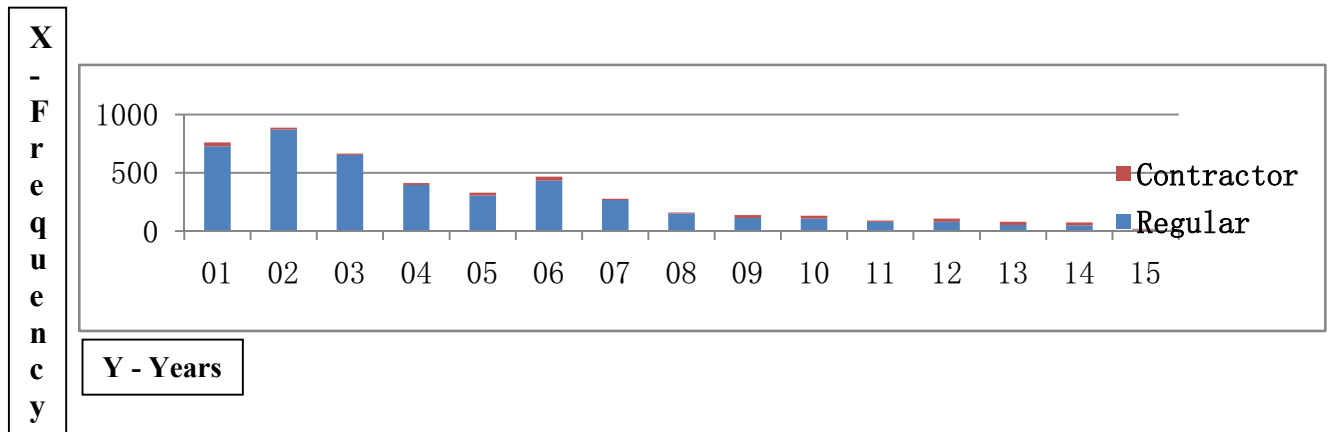


Figure 3.4 Non reportable accident in SAIL plotted with frequency of injuries in x-axis and year in y-axis

Table 3.1: Fatalities In Sail & Other Steel Producers

Year → ----- Company ↓	2010	2011	2012	2013	2014
SAIL	33	21	27	23	27
TATA	2	2	6	4	1
RINL	2	8	25	3	5

ESSAR		7	1	2	0	14
JSW Steel Ltd.		5	8	11	6	5

### 3.1.2 Lost Time Injury Frequency Rate( World Steel Member Cos.)

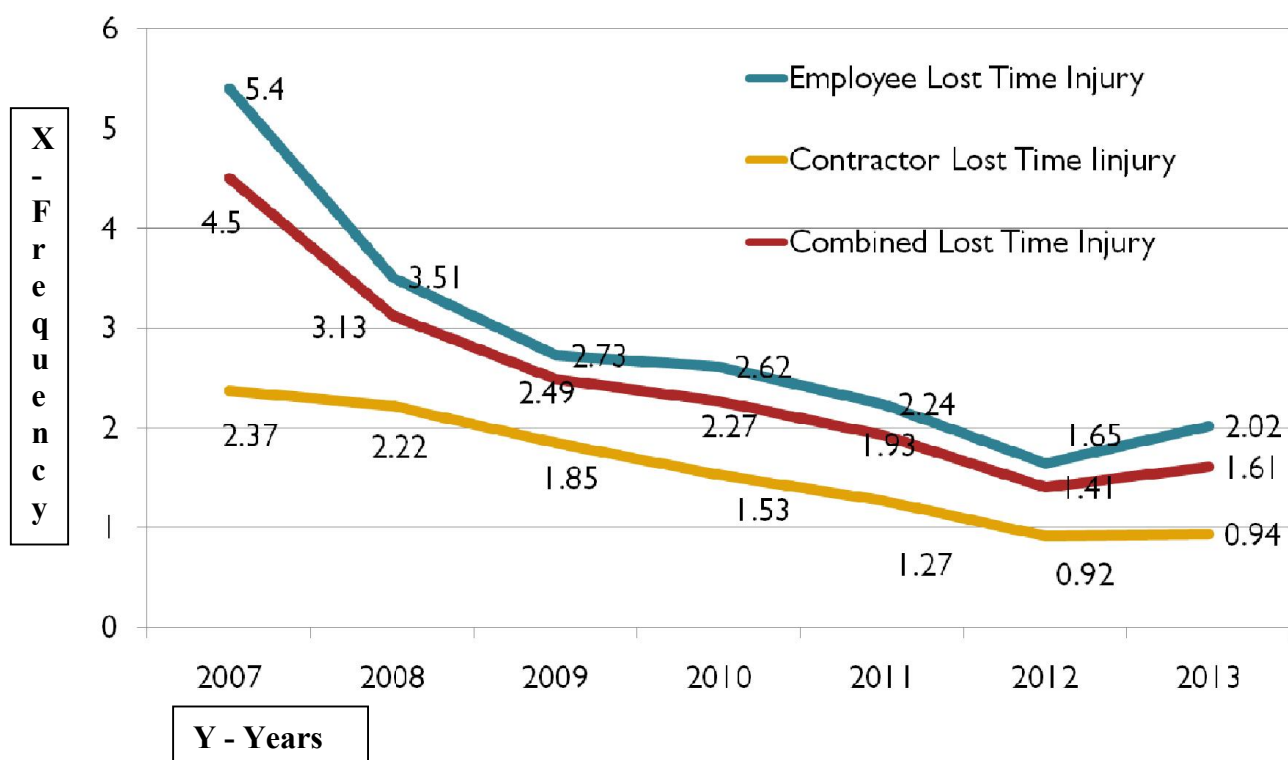


Figure 3.5 Loss time injury rate in which frequency is plotted in X-axis and year in Y-axis

## 3.2 Safety Training And Drives

### 3.2.1 Safety Training

The following training program is followed:

a) By SSO through external faculties – These following programs is covered:

i. HAZOP Study

- ii. Process Safety
  - iii. Safety Audit
- b) At Plants through in-house experts in the areas of:
  - i. Fatality Risk Control
  - ii. Gas Safety
  - iii. Project Safety
  - iv. Safety management for DSOs

### **3.2.2 Safety Drives**

The following safety drives are taken into account:

- i. Tool box Safety Talk
- ii. Provision of Double earthing
- iii. Usage of ELCB
- iv. Provision of Chicken mesh guard in man coolers
- v. Machine guarding & barricading
- vi. Road safety
- vii. Flash back arrestor in Gas cutting sets & cylinder

## The Shift Requires Focus On People....

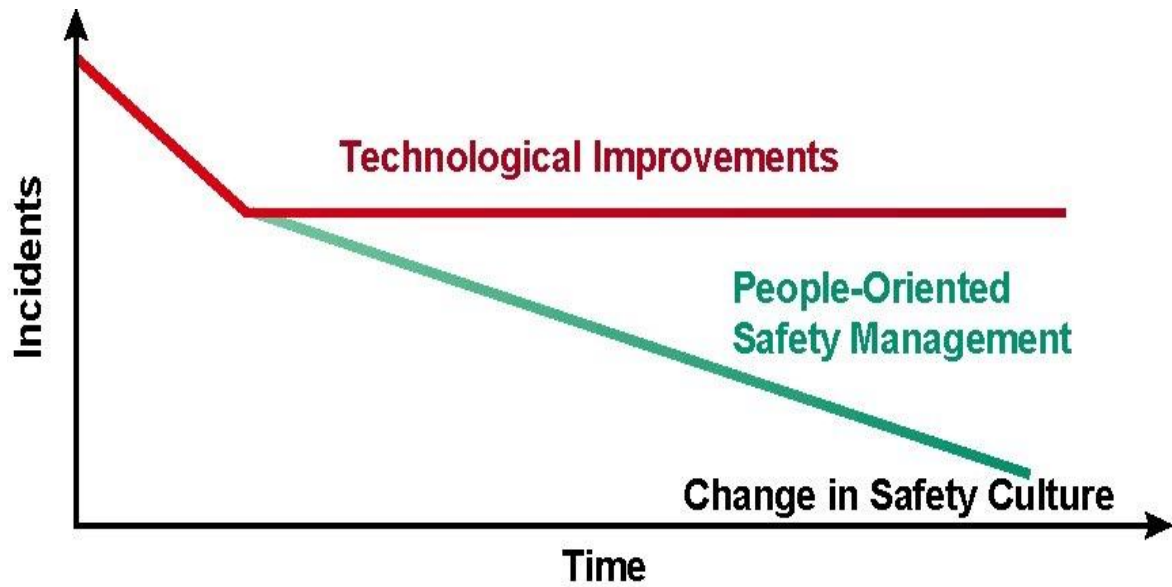


Figure 3.6 Incidents And Time Are Plotted To Show The Safety Culture

### 3.3 Safety At Rourkela Steel Plant(RSP)

Safety in steel industry is a complex and multi-disciplinary phenomenon due to various operational and maintenance activities and therefore modern industrial safety procedures are being merged with technology at RSP to provide methods for complete elimination of accidents. Rourkela Steel Plant gives specific effort on system safety, engineering control and behavioral aspects of humans to prevent accidents, in order to achieve its long cherished goal of producing Accident Free Steel. The Zero Accident Recognition Scheme, campaigns for Road Safety, Zero Accident Month and Suraksha Mela are some of the many important initiatives taken up by the Steel Plant in this direction. Rourkela Steel Plant has got the unique distinction of having its Blast Furnaces receiving the RCGS Diamond Certification for three consecutive years viz. 2006-07, 2007-08 and 2008-09. Creating awareness is one of the most important ways to curb various safety hazards. In line with this thinking Rourkela Steel Plant organizes various competitions like Safety skit, safety elocution, safety song, safety slogan writing and an array of other events throughout the year for inculcating safety consciousness amongst its employees.

### **3.3.1 Safety Functions At RSP**

In RSP, safety is an integral part of main business activity. The dictum “Safety First Production must” has successfully been converted into a ground reality. The organization is continuously striving to achieve new heights of excellence by inculcating a voluntary & sustainable Culture of safety through well planned pro-motive & pro-active activity.

The organization has a well established Safety Department reporting directly to the Executive Director (Works) who presently acts as the declared “Occupier” in organizational hierarchy. There is in place a clearly spell out safety policy. The visible commitment of top Management in implementing its Safety Policy has truly been inspiring to its employees.

The centralized Safety Department practically operates as a line function. It translates Safety Policies into realities by monitoring safety efforts in all the units under RSP. It undertakes regular routine activities of preventive safety using all the known techniques of Safety Management like inspection, investigation, system audit, safety training, emergency preparedness planning etc. etc. The department is ably supported in its function by 50 Nodal Safety Officers nominated one each from all the hazardous units / departments.



**Table 3.2 Accidents/Injuries occurred in RSP from January 2015 till March 2016**

Sl no.	Accident/ injury	Jan '15	Feb '15	Mar '15	Apr '15	May '15	Jun '15	Jul '15	Aug '15	Sep '15	Oct '15	Nov '15	Dec '15	Jan '16	Feb '16	Mar '16
1	Fall of a person	0	0	1	2	0	1	1	1	0	0	0	0	0	0	0
2	Fall of an object	0	0	0	1	0	0	2	0	1	1	1	0	1	1	1
3	Stepping/s triking against	1	1	5	1	2	1	6	5	1	2	2	0	3	0	2
4	Caught in between objects	0	0	1	0	0	0	0	0	2	0	0	1	0	2	0
5	Over exertion	1	1	0	1	1	0	0	0	0	1	0	0	0	0	1
6	Exposure to harmful substance	3	3	2	2	1	3	1	3	3	2	1	0	2	0	1
7	vehicles	1	1	3	3	2	2	7	2	4	2	1	0	1	1	2
8	Sprains	1	2	0	1	0	2	2	0	2	0	1	3	0	0	0
9	Internal injury	1	0	0	1	0	0	1	0	0	0	2	0	2	1	0
10	Superficial injury	3	1	0	5	4	1	3	4	1	3	1	0	4	2	1
11	Spinal injury	1	1	0	0	0	0	1	0	1	1	2	3	0	1	2
12	Burns	1	0	1	0	2	3	1	0	2	5	3	1	1	2	1
13	Multiple injury	0	0	0	0	1	0	1	1	0	2	0	1	0	0	0

### 3.4 Results and discussions

From the graphs of trend of fatal accidents the rate of fatalities has been considerably decreased from 2004 to 2015. and with rapid adaptation in the process of safety the rate of fatalities has been reduced alot. The rate of reportable accidents has also considerably reduced in the following years. From the analysis of near miss cases the reported near miss which was done includes slips and trips 8%, electrical category 4%, vehicle 21%, falling of objects 21%, material handling 21%, hot work 20%. Even the rate of non reportable accidents has been reduced. And compared to the year 2004 where the number of accident was 395 has been reduced to 13 in the year 2015.

## **Chapter 4**

# **Analysis on Kolkata flyover collapse**

### **4.1 Introduction**

On 31st March 2016, an under construction flyover bridge named "Vivekananda flyover" in Kolkata nearby Girish park got collapsed. The construction was done in a congested area of Kolkata. The incident took place at busy road "Rabindra Sarani" where normal traffic was going on. This disaster added up one more example to manmade disasters.

The construction of the flyover was contracted in the year 2008 and the work started in 2009. The construction of the flyover was started by IVRCL, a Hyderabad based construction firm who won the bid of the project. The project was scheduled to complete in 2012 but due to various issues the company could not make up to complete the project on time and crossed many deadlines. The final deadline for the flyover completion was May 2015 but it was missed. The frequent delays and cost overruns may have taken a toll on the structure which is a frequent problem with infrastructure projects. And the very first reason which strikes to mind for the collapse may be because of delay in the construction of the flyover. 250 meters of the 2.2 kilometer long Vivekananda flyover crashed on to the traffic around 12.30pm near the important district of Kolkata, Burra-bazar.

The flyover collapse killed at least 22 people and trapped hundreds under the giant steel frames and concrete slabs. The official death toll was 19. One day before the collapse concretization was done as said by the local people and even the workers who were working over there. And hours before the collapse the construction workers heard the noise of cracking nuts in the cantilever but somehow ignored. Due to the ignorance of the workers, engineers and other administrative person the result is so adverse. The flyover was supposed to be the longest bridge in the city and the basic purpose of the construction was to ease the traffic by connecting the packed Central Avenue to Howrah bridge.

This report gives an overall idea of the flyover collapse with the possible causes, outcomes, safety aspects and issues with some recommendations.

#### **4.1.2 Brief Description On IVRCL**

IVRCL(Iragavarapu Venkata Reddy Construction Limited) is a company engaged in the business of development and execution of engineering, procurement, construction and commissioning (EPCC) facilities. The Company's segments include Engineering & Construction, Real Estate and Manufacturing. It operates in various infrastructure projects, such as water supply, roads and bridges, townships and industrial structures and power transmission for central/state governments, other local bodies and private sector. It is involved in water and environmental projects, including water distribution systems, desalination projects and environmental projects. It is also engaged in transportation projects, such as integrated toll collection, bridges, tunnels and railways. Its buildings and industrial structures include integrated townships, composite housing projects, hospitality and various other infrastructure projects. Its power transmission projects include substations and owned manufacturing tower factory, among others.

Now coming to flyover collapse IVRCL, a Hyderabad based construction firm won the bid of the project. The project was contracted in the year 2008 and the work started in 2009. the construction was scheduled to complete in the year 2010 but have crossed many deadlines. the last deadline was in May 2015 but then also it was not able to meet the deadlines. recently as the elections was near the company was in a hurry to complete up the work as soon as possible and the construction was carried out in such a heavy traffic without taking care of any safety aspects.

#### **4.1.3. Advantage Of The Construction Of Vivekananda Flyover**

In order to ease Howrah bound traffic movement from Eastern side, the then Left Front government had proposed construction of the flyover connecting Vivekananda Road with Strand Road avoiding traffic of Burrabazar and its adjoining areas. The Traffic jam between Strand Road and Ganesh Talkies is a regular problem and it was thought that this traffic problem would be avoided by constructing a flyover. The traffic congestion due to heavy vehicles will considerably reduce after the inauguration of the flyover.

#### **4.1.4. Incident/ Accident**

On 30th March 2016, one day before collapse concretization was done for the bridge and hours before the collapse the construction workers heard the cracking sound of nuts in the cantilever. And on 31st March 2016, at 12.40 pm IST a 150 meter span of steel of the bridge got collapsed and trapped many pedestrians and vehicles under it. It is a case of sudden failure. This incident took place at the busy road which killed 27 people, injured 80 others.



**Figure 4.1 Sudden failure of the flyover**



Figure 4.2 Rescue operations



Figure 4.3 Rescue operations carried out



**Figure 4.4 View of the flyover from a residential apartment**

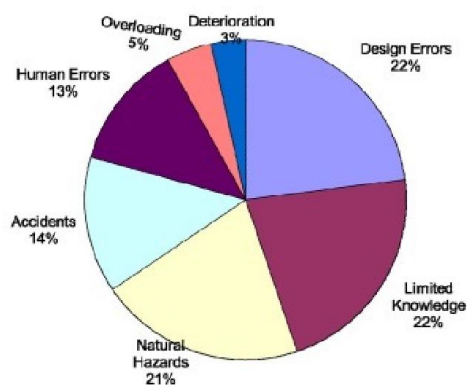
#### **4.1.5. Possible Reasons For Collapse Of The Flyover**

Since concretization was done a day before the collapse, thus, sometimes a portion of deck particularly cantilever portion collapses due to failure of temporary support. But such failure occurs when concretizing is in progress as wet concrete weighs more than set concrete. Thus these may be the reasons for failure:

- a) Design aspects- The design aspect needs to be take care of as due to space constraint and traffic load the construction was done without restricting the traffic movement. The fault was there in the pier cap which lead to failure.
- b) Execution aspects- The standard operating procedure of such execution needs to be ensured with approved material sourcing, fabrication by experts, pre inspection and post inspection. Each span should undergo these process. But may be due to confidence after owning from successful completion of all other spans the supervisors would have neglected in checking the process of material sourcing, fabrication, pre and post inspection.

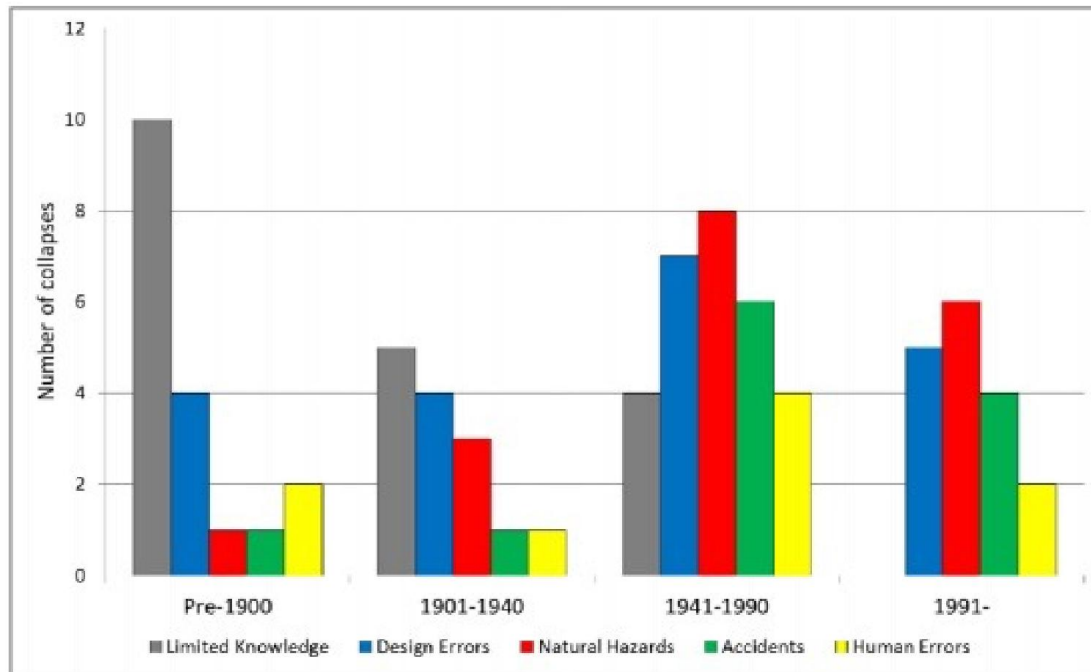
- c) The size, shape or the choice of material is an important aspect because of this we can know whether the structure is strong enough to take the load or not. And the structure is not strong enough then catastrophic failure occurs.
- d) Instability of the structure- Change in geometry, design and material choice leads the structure fail out of fatigue or corrosion. This structure under compression results in loss of ability to resist loading is defined as instability. Instability can lead to catastrophic failure that must be accounted in design. Instability is a strength-related limit state.
- e) Manufacturing errors can also lead to failure of structure. This can be due to improper selection of materials, incorrect sizing, improper heat treating, design failing or improper workmanship
- f) Insufficient steel girders were used.
- g) Faulty placement of steel girder could lead to the collapse.
- h) Defect in construction process- This includes both design and workmanship defects. design defects is because of an error or omission or sometimes both. Workmanship defects arise due to failure in construction due to contractors fault.
- i) Since concretization was done one day before the accident, the concrete remains in a weak state and it has weight but has not achieved its load bearing capacity
- j) Implementation problem-There may be some issues with the framework which lead to the failure.
- k) Reinforcement failure- This failure occurs if spacing in the reinforcement provided is not proper and diameter issue of the column might be there. If at all percentage of steel is high then there is over reinforcement and it may lead to sudden failure of any structure.
- l) Foundation and settlement problem- Since here foundation has been laid in 2008 and project began on 24th Feb 2009 which is supposed to complete by 2012 but land acquisition issues and financial problems delayed its completion

- m) Administrative issues- engineers and supervisors sometimes due to over confidence take things for granted which leads to an adverse effect on human life and society in the long run.
- n) Lack of proper planning, delays, lacunae in design and bad tendering may lead to collapse.
- o) Lack of consideration of unexpected problems like land acquisition problems, natural disasters which may lead to failure. Improper training and lack of supervision and maintenance of construction work can also lead to failure.

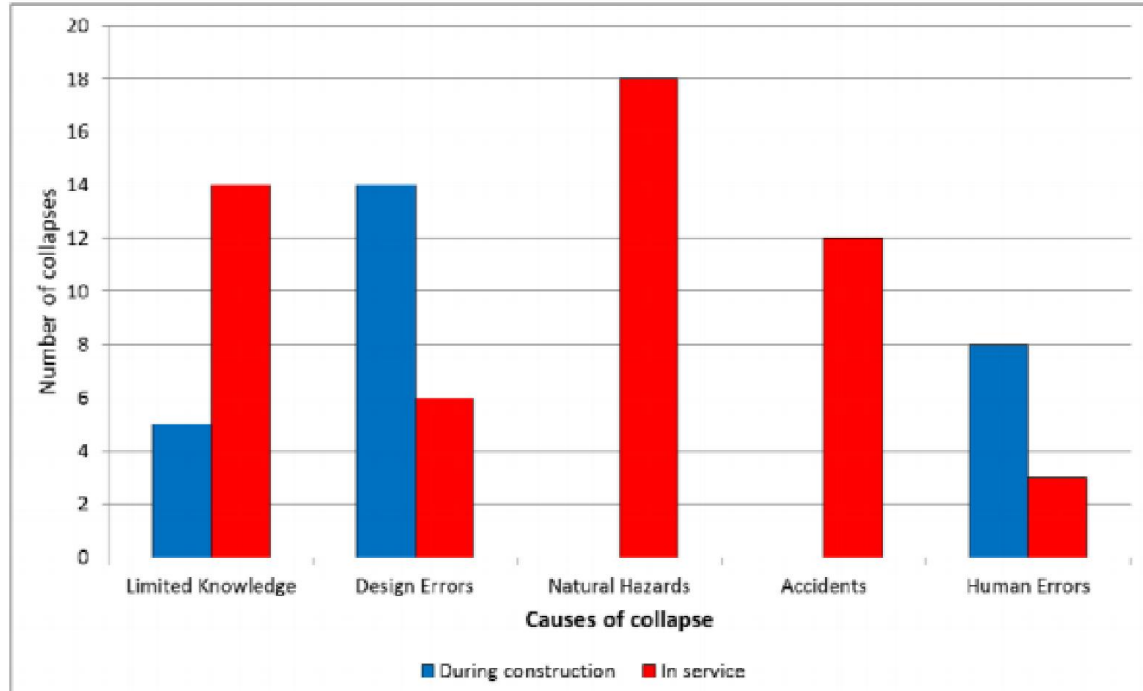


**Figure 4.5 Failure causes leading to bridge failure**





**Figure 4.6 Causes of bridge collapse by date(Referred from B.M. Imam & M.K. Chryssanthopoulos ,Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, UK)**



**Figure 4.7 Cause of bridge collapse by stage(B.M. Imam & M.K. Chryssanthopoulos ,Faculty of Engineering and Physical Sciences, University of Surrey, Guildford, UK)**

#### **4.1.6 Expert Views On The Flyover Collapse**

The long delayed 2.2km Vivekananda flyover was expected to ease the traffic congestion problem in Burra-bazaar area. But it ultimately collapsed leading to 27 dead and 90 injured.

After this incident, IIT Kharagpur, Professor architecture faculty , Joy Sen, said that such large scale construction projects are to be executed in phases and if time is neglected then the consequences can be worse. Phasing of construction, time and use of materials are interlocked. and if all these things are not done in time then construction which are exposed to weathers become risky.

Time schedule is the most important factor which needs to take care and one cannot delay in these type of projects. Proper planning should be made because no one has the right to play with human lives. One major thing which should be considered is that construction projects and tendering practices should be based on experiences and should not be simply handed over to any random firm which quotes for lowest price.

#### **4.1.7 Consequences And Losses**

The collapse of the bridge lead to various consequences and losses. The consequences and losses are categorized in the following table 4:

**TABLE 4.1: Consequences and losses of bridge failure**

<b>CATEGORIES</b>	<b>LOSS</b>
1. Human	Fatalities
	Injuries
	Psychological
2. Economic	Replacement/ Repair cost
	Loss of functionality
	Traffic delay
	Traffic management costs
	Clean up costs
	Rescue costs
	Compensation
3. Social causes	Loss of reputation
	Loss in public confidence
	Changes in professional practice

## Chapter 5

# Conclusion

The safety officers in SAIL are working over the safety issues and problems which the industry is facing in long run. They are even taking sessions everyday in order to teach the workers how to work safely in various environment in industries. The graphs and reports tells us that their a reduce in the level of reportable and non reportable accidents in all the branches of SAIL. Moreover SAIL is trying to achieve a zero accident rate and is been working and somewhat achieved the goal.

As per the report published by different news the number of injuries in this flyover case is 90 and fatalities were 27. The families of the person dead were given a compensation of Rs 5 lakh each and Rs 2 lakh each for those critically injured and Rs 1 lakh each for those who suffered minor injuries. This incident/ accident is an eye opener to the construction industry and the various firms who are dealing with this kind of work in their day to day life. This incident also showed how safety is the most important aspect in any of the startup work in any industry whether construction industry or chemical industry, etc. Our country has rules and regulations for safety but the implementation part is still at infancy. So for the start up, its, we the people who have to start the safety work and follow the basics of safety. For this proper training needs to be provided. This safety practices should not be limited to books, it should be implemented and checked by specialized officers in order to avoid such collapse accident in the long run.

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